

Description

[METHOD OF ENHANCING THE ADHESION BETWEEN PHOTORESIST LAYER AND SUBSTRATE AND BUMPING PROCESS]

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the priority benefit of Taiwan application serial no. 92122955, filed August 21, 2003.

BACKGROUND OF INVENTION

[0002] Field of the Invention

[0003] The present invention relates to a method of enhancing the adhesion between photoresist layer and a substrate and a bumping process. More particularly, the present invention relates to a method of enhancing the adhesion between photoresist layer and a substrate and a bumping process that utilizes at least two photoresist layers having different viscosity.

[0004] Description of the Related Art

[0005] In this information technology society, the use of multi-media systems is expanding at an ever increasing rate. As a result, integrated circuit manufacturers have produced countless new digital electronic devices capable of networking and catering for a variety of personal tastes. To meet the demands of most customers, the electronic device must have a high processing speed, many powerful functions, highly integrated circuits, a miniaturized body having very little weight and a low selling price. Following this trend, the circuit density inside many integrated circuit packages are increased to produce high package density packages such as the ball grid array (BGA) packages, the chip scale packages (CSP), the flip-chip (F/C) packages and the multi-chip modules (MCM). The quality of a package is often assessed according to its integrated circuit package density, which is the number of pins per unit area. For a high-density integrated circuit package, a shorter average wiring length is often translated into a higher signaling speed. Since bump connection is able to shorten transmission length considerably, its application is widespread in high-density packages.

[0006] Figs. 1A through 1F are schematic cross-sectional views showing the steps in a conventional bumping process. As

shown in Fig. 1A, a wafer 100 having a plurality of bonding pads 102 thereon is provided. A passivation layer 106 is formed over an active surface of the wafer 100. The passivation layer 106 exposes the bonding pads 102. The wafer further has an under-bump metallurgy (UBM) layer 104 disposed over the exposed active surface and a portion of the passivation layer 106 around the bonding pad 102.

- [0007] As shown in Fig. 1B, a photoresist layer 108 is formed over the wafer 100. Thereafter, as shown in Fig. 1C, a photolithography and development process is performed to form a plurality of openings 108a in the photoresist layer 108 above the bonding pads 102. Through the openings 108a, a portion of the under-bump metallurgy (UBM) layer 104 is exposed.
- [0008] As shown in Fig. 1D, a solder material is deposited to fill the openings 108a by stencil printing process so that a plurality of solder posts 110 is formed over the UBM layer 104. As shown in Fig. 1E, the photoresist layer 108 is removed to expose the solder posts 110.
- [0009] As shown in Fig. 1F, a reflow process is then performed to heat the solder posts 110 into a partially melted state so that a spherical-like solder posts 110 is formed due to the

cohesion thereof. Then, the spherical-like solder posts 110 are cooled and form a plurality of spherical bumps 110a.

[0010] In the aforementioned bumping process, the top surface of the passivation layer is typically rough so that the photoresist layer can not adhere entirely on the top surface of the passivation layer. Thus, gaps are often formed between the photoresist layer and the passivation layer. However, with the ever-increasing density in the integrated circuit package, the pitch between neighboring bonding pads is getting smaller and smaller. When the solder material are filled into the openings to form the solder posts, some of the gaps may also be filled by the solder material so that two neighboring bonding pads will electrically bridge through the solder material.

[0011] Fig. 1G is a schematic cross-sectional view showing a portion of the region between neighboring bumps fabricated according to a conventional bumping process. As shown in Fig. 1G, the aforementioned steps of performing a photolithography and development process to form openings in the photoresist layer 108 and filling the openings by a stencil printing process to form solder posts 110 are similarly applied. However, due to the gaps

112 formed between the passivation layer 106 and the photoresist layer 108, some of the solder material may be filled into the gaps 112 so that the bonding pads 102 on each side of the gaps 112 will electrically bridge through the solder material.

SUMMARY OF INVENTION

- [0012] Accordingly, the present invention is to provide a bumping process capable of preventing the electrical bridging phenomenon occurring between two neighboring bonding pads.
- [0013] As embodied and broadly described herein, the invention provides a bumping process comprising the following steps. First, a wafer having a plurality of bonding pads and a passivation layer that exposes the bonding pads is provided. A metallic layer is formed over the wafer to cover at least the bonding pads. Thereafter, a first photoresist layer is formed over the wafer and then a second photoresist layer is formed over the first photoresist layer. The first photoresist layer has a viscosity smaller than the second photoresist layer. After that, a photolithography process is performed to form a plurality of openings in the first photoresist layer and the second photoresist layer. The openings expose the metallic layer above the

bonding pads. A solder material is filled into the openings to form a plurality of solder posts. Finally, the first photoresist layer and the second photoresist layer are removed.

- [0014] In the bumping process of the present embodiment, the solder material is filled into the openings by electroplating or stencil printing. Furthermore, after removing the first photoresist layer and the second photoresist layer, a reflow process is performed to form a plurality of bumps over the metallic layer. In addition, the first photoresist layer and the second photoresist layer are dry films, for example.
- [0015] The bumping process of the present invention utilizes two types of photoresist layer having different viscosity. The photoresist layer adhered with the passivation layer has a smaller viscosity or higher fluidity so that the photoresist layer is able to adhere tightly with the passivation layer. Hence, there is no gaps and electrical bridging phenomenon between the photoresist layer and the passivation layer, thereby providing an effective isolation between two neighboring bonding pads.
- [0016] The present invention also provides a method for enhancing the adhesion between a photoresist layer and a sub-

strate. First, a first photoresist layer having a lower viscosity is formed over the substrate. Thereafter, a second photoresist layer having a higher viscosity is formed over the first photoresist layer. The first photoresist layer and the second photoresist layer are dry films, for example.

- [0017] The method of enhancing the adhesion between a photoresist layer and a substrate can be applied to join together various types of photoresist layers and substrates beside the aforementioned bumping process.
- [0018] It is to be understood that both the foregoing general description and the following detailed description are exemplary, and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF DRAWINGS

- [0019] The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.
- [0020] Figs. 1A through 1F are schematic cross-sectional views showing the steps in a conventional bumping process.
- [0021] Fig. 1G is a schematic cross-sectional view showing a

portion of the region between neighboring bumps fabricated according to a conventional bumping process.

[0022] Figs. 2A through 2G are schematic cross-sectional views showing the steps in a bumping process according to one embodiment of the present invention.

DETAILED DESCRIPTION

[0023] Reference will now be made in detail to the present embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

[0024] Figs. 2A through 2G are schematic cross-sectional views showing the steps in a bumping process according to one embodiment of the present invention. As shown in Fig. 2A, a wafer 200 having a plurality of bonding pads 202 and a passivation layer 206 that exposes the bonding pads 202 is provided. A patterned under-bump metallurgy (UBM) layer 204 is further disposed over each bonding pad 202. It should be noted that the top surface of the passivation layer 206 is not always a smooth flat surface so that a photoresist layer formed over the passivation layer 206 may not tightly adhere with each other resulting in the formation of gaps 206a. In a subsequent printing

process, some of the solder material may be filled into these gaps 206a to form an unwanted solder bridge that electrically connects two neighboring bonding pads 202 on each side of the gaps 206a. In the prevent invention, two types of photoresist layer having different viscosity are used to mitigate this problem.

[0025] As shown in Figs. 2B and 2C, dry films or other types of photoresist layers are sequentially applied over the wafer 200 to form a first photoresist layer 208 and a second photoresist layer 210 that cover the bonding pads 202, the UBM layer 204 and the passivation layer 206. It should be noted that the first photoresist layer 208 must have a viscosity lower than the second photoresist layer 210. With a smaller viscosity, the photoresist material can fill into tiny gaps 206a easily so that the first photoresist layer 208 and the passivation layer 206 are tightly adhered to each other.

[0026] As shown in Fig. 2D, an exposure and development process is performed on the first photoresist layer 208 and the second photoresist layer 210 to form a plurality of openings 212 that exposes the UBM layer 204 above the bonding pads 202.

[0027] As shown in Figs. 2E and 2F, a solder material is filled into

the openings 204 and form a plurality of solder posts 214 by a stencil printing process, for example. Thereafter, the first photoresist layer 208 and the second photoresist layer 210 are removed.

- [0028] As shown in Fig. 2G, a reflow process is performed to melt the solder posts 214 and transform the solder posts 214 into spherical shape through cohesion. After the solder material is cooled, a plurality of bumps 214a is formed over the under-bump metallurgy (UBM) layer.
- [0029] In summary, the bumping process of the present invention utilizes two photoresist layer having different viscosity to enhance the adhesion between the photoresist layer and the passivation layer. With a lower viscosity, the photoresist material can fill the gaps on the surface of the passivation more readily. With all gaps filled, the solder material can no longer be filled into the gaps to form a solder bridge between neighboring bonding pads and result in an abnormal connection.
- [0030] Although a bumping process is provided in the aforementioned embodiment to illustrate a method for enhancing the adhesion between a photoresist layer and a substrate, the method can be applied to various types of substrates. Furthermore, a variety of photoresist materials can be

used and combined to fit a diversity of application environments.

[0031] It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the present invention cover modifications and variations of this invention provided they fall within the scope of the following claims and their equivalents.